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NOTES AND MEMORANDA

No. 3

The Kidney-worm of Swine:

Stephanurus dentatus

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RECENT work has revealed the fact that the kidney-worm of pigs is, in certain countries, of considerable economic importance, and that it has an unexpectedly wide geographical distribution. This parasite does not make its presence in the living animal as obvious as do intestinal worms, since neither worms nor eggs are voided in the fæces, and examinations of urine, as distinct from fæces, are not often made a matter of routine. The pathological and economic effects of the parasite are therefore all the more insidious. Investigations on this disease are proceeding in various parts of the Empire, and on this account the Imperial Bureau of Agricultural Parasitology has thought it opportune to prepare the present bibliography and notes.

The bibliography deals mainly with references published in scientific literature, but it is realized that there will probably be many further references in veterinary and agricultural Departmental Reports. In view of the importance of the subject it would be helpful if the attention of the Bureau might be drawn to any of these.

CLASSIFICATION.

Diesing, who in 1839 described the kidney-worm of swine and named it *Stephanurus dentatus*, states that this nematode was first discovered at Barra do Rio Negro in Brazil by Natterer in 1835 among layers of fat in a domestic pig. In 1858 it was found in the perirenal fat of pigs in the United States by White who recognized it as *Stephanurus dentatus*, although further material collected by White was described by Verrill in 1870 as *Sclerostoma pinguicola* in apparent ignorance of Diesing's work.

In the following year Cobbold (1871) received material from Morris in Australia which he unhesitatingly identified as Diesing's species.

Since then there has been much confusion in nomenclature, as the table of synonyms will show. The species *dentatus* has been placed at different times in the genera *Strongylus* and *Sclerostoma* where it has led in each case to confusion with Rudolphi's species *dentatus* (1803), for this worm (now known as *Oesophagostomum dentatum*) is also found in pigs. In the absence of rules of nomenclature Cobbold (1879) suggested the specific name *nattereri* in honour of the discoverer. Drabble (1922), regarding the Australian worms as a distinct species, proposed for them the name *Sclerostoma renium*, but Cameron & Clunies Ross (1924) re-examined material from New South Wales and denied the necessity for a new specific name. Tayler (1900) regarded the worm as a *Sclerostoma* and, in view of Rudolphi's species *Sclerostoma dentatum*, argued that *pinguicola* should stand as its name. This argument was rejected by Looss (1904 and 1905), amongst others, and the present accepted position is that the swine kidney-worm should be known as *Stephanurus dentatus* Diesing, 1839. The synonymy may be set out as follows :—

Stephanurus Diesing, 1839.

Stephanurus dentatus Diesing, 1839 (Monotypic).

Synonymy.—*Sclerostoma dentatum* (Diesing, 1839) Leidy, 1856 ; *nec* Ruldolphi, 1803.
Sclerostoma pinguicola Verrill, 1870.
Strongylus dentatus (Diesing, 1839) Dean, 1874 ; *nec* Rudolphi 1803.
Stephanurus nattereri Cobbold, 1879.
Strongylus pinguicola (Verrill, 1870) Magalhães, 1894.
Sclerostoma renium Drabble, 1922.
Stephanurus morai Almeida, 1928.

The principal characteristic of *S. dentatus*, says this last author, " Is the position of the vulva which is situated near the middle of the body. In our case this characteristic is not found, which enables us to consider this strongyle . . . as a new species." Thus do original errors, repeated in text-books, subsequently lead to confusion, as will be seen (under " Morphology ") below.

Geographical Distribution

As mentioned above, the worm was early recorded from South America, the United States and Australia. Its distribution, as known at present, is considerably wider than that. Correspondents have reported to this Bureau that it occurs in Queensland, New South Wales, Fiji, South Africa, the Gold Coast, Seychelles, Trinidad and St. Kitts. It is described as a serious pest in Java and Sumatra by Hellemans (1911), and is recorded from Annam by Railliet & Henry (1911) and by Bernard & Bauche (1913). In the Philippines it has been dealt with in several papers (Best, 1914 ; Boynton, 1913 and 1914 ; Newcomb, 1913, and Schwartz, 1925). As regards the New World, apart from the United States records already mentioned, it is recorded from the Argentine and from Uruguay by Wolffhügel (1911 and 1919), and from Devil's Island by Rousseau (1921), and Cameron (1930) states that " The most important of the nematodes occurring in West Indian pigs is undoubtedly *Stephanurus dentatus*." In Africa, while Mönnig (1928) lists it as rare in South Africa, it is plentiful in the more tropical regions. Thus it has been recorded from Portuguese East Africa (Joyeux, 1924 ; le Roux, 1930 B), Dahomey (Pécaud, 1912 ; Bernard & Bauche, 1913), Angola (Almeida, 1928), French and Belgian Congo and Madagascar (le Roux, 1930 A). Material has been sent to Professor R. T. Leiper, and is housed in the collection of the Helminthology Department of the London School of Hygiene and Tropical Medicine, from New Guinea (sent by Dr. Heyden), Hong Kong (sent by Mr. F. Davidson) and British Guiana (sent by Mr. H. A. Moonsawmy). Finally, although hitherto regarded as absent from Europe, it has recently been recorded by Lopez-Neyra (1929) as occurring (4 females and 6 males) in a pig fattened and killed in Granada and probably born and bred there. Thus it will be seen that the parasite is widely present in tropical and sub-tropical regions where pigs are kept.

The parasite has been recorded from various organs within the host (Leuckart, 1876 ; Hellemans, 1911, and recent authors), including perirenal tissues, pelvis of the kidney, walls of the ureter and adjacent tissues, liver, lungs and spleen, peritoneal and thoracic connective tissues, right heart, portal vein and vena cava. It can now be regarded as probable that the normal sites are the liver (for larvæ and immature adults) and the tissues associated with the excretory organs (for mature adults) :

in view of the life history described below it is easy to see how other organs might become sporadically infected. The adults come to lie (often in pairs) in cysts or in pockets of pus which communicate with the lumen of the excretory organs. Although normally a parasite of the pig, *Stephanurus dentatus* has been recorded from cattle in the United States, usually from the liver where it probably fails to mature. Spindler (1930) has described an immature form from the neighbourhood of the kidney in a yearling calf. There are specimens in the Helminthology Department of the London School of Hygiene and Tropical Medicine (sent to Professor R. T. Leiper by Mr. C. M. G. Hoyte) from the liver of a cow from the Gold Coast. And Mr. J. L. Stewart, the Bureau's Official Correspondent in the Gold Coast, has reported it from an uncertain situation in a donkey.

Morphology and Life History.

Stephanurus dentatus is a nematode of the strongylid type, with its almost globular mouth-capsule and the bursa surrounding the male tail, but several of its strongylid features are but feebly developed. Females occur almost two inches in length (34 mm.-45 mm.) and the males are a little more than half this size (22 mm.-30 mm.). They are respectively about 2 mm. and 1 mm. broad. The mouth capsule, which is thick-walled, is surmounted by a small external leaf-crown (corona radiata) and by six externally reflected lips ("epaulettes," Skrjabin (1921) calls them) of which the ventral and dorsal are more highly developed. At its base is a variable number of teeth (or six teeth with a varying number of cusps). In the male is a feebly developed bursa with short stout rays, a pair of spicules which may be equal or unequal in length (1 mm. or less) and an accessory piece shaped like a broad arrow-head. Diesing (1839) erroneously described a single spicule and his error has been repeated in numerous text-books, e.g., Neumann (1905), p. 469 ; Underhill (1920), p. 295. In the female the vulva is near the anus behind which the body ends abruptly in a short stumpy tail flanked on each side by a large globular papilla. Here again, Diesing originally described the vulva as being at the beginning of the posterior half of the body, and although he corrected this error in his "Systema" (1851) and "Revision" (1861A) it has been repeated in the older text-books, e.g., Underhill, *loc. cit.*, and see *S. morai* above (in "Classification"). The two uteri run parallel. The eggs, which measure about 0·1 mm. by

0·06 mm., do not hatch until one or two days after they leave the body of the host, normally in the urine. Another 4 or 5 days elapse before the embryos reach the infective stage, so that there is a period of about a week during which the life-cycle can be effectively broken by the pig farmer. Given conditions of heat and moisture the infective larvæ can live for some months, but dryness and low temperature are equally fatal.

Modes of Infection.

There is some difference of opinion regarding the mode of entry into the body of the host. Bernard & Bauche (1913 & 1914) state that infection is principally through the skin (leading to infection of the excretory organs) and less commonly through the mouth (leading to infection of the liver). Thus at Dahomey all infected pigs showed both perirenal and hepatic lesions, while at Annam, although perirenal lesions were invariably found, only 4 per cent. of infected pigs revealed liver infestations. Wolffhügel (1919) finds himself in complete agreement with this theory. Schwartz & Price (1929), however, state that, while the placing of the larvæ on scarified skin or the nasal mucosa or injecting them subcutaneously or administering them by mouth invariably leads to infection, yet the larvæ reach the liver irrespective of the mode of entry, that they come to the surface of the liver, and that they probably migrate actively thence to the adjoining perirenal fat and to the ureters. The researches of Clunies Ross and of Kauzal (see Ross, 1931) indicate that the larvæ enter through the mouth or actively penetrate the skin with equal facility, that they reach the liver in either case and that they do not leave that organ until they are some 5 or 6 months old. Incidentally, Clunies Ross (1931, Fig. 1) gives a photograph of a pig clearly showing skin-nodules at the site of, and 11 days after the time of, artificial infection : these lesions disappeared in a few days. A somewhat similar photograph is given in Bernard & Bauche (1914). Rousseau (1921) states that in Devil's Island hepatic lesions predominate and are the first to appear.

Pathology.

Although the worms cause hypertrophy of the tissue surrounding the kidneys and ureters they appear not to cause much ill-health thereby (Ross, 1931). Boynton (1914), however, states that in long-standing cases the actual tissues of the kidney, and practically every cavity of the body,

are invaded. Opinion is divided as to whether this disease causes posterior paralysis in pigs or not. Fletcher (1871) thought so, and American opinion has tended to take this view. But now that it is reasonably certain that all the larvæ pass into the liver and there undergo considerable development, it is obvious that the worm must have a hitherto unsuspected pathogenic importance. As Clunies Ross says (1931, p.31) : " The worm gives rise to great destruction of liver tissue, and may cause serious thrombosis of the blood vessels. Even where this does not lead to the death of the animal, the consequent fibrous formation and liver derangement may lead to serious interference with normal liver function, the effects of which may be shown in stunted growth and abnormal development." And Rousseau (1921) suggests that the poor condition of the pigs in Devil's Island, commonly attributed to malnutrition, may well be due to the severe hepatic lesions caused by this parasite.

Prophylaxis.

As regards prophylaxis, le Roux has well quoted Leuckart's admonition : " Swine should be kept in a less swine-like manner." It is clear from what has been said concerning the life-history of this parasite that where pigs are kept under ideal conditions of cleanliness (e.g., confined in concrete-floored sties that are frequently cleaned) they could not easily pick up or retain the infection. Such conditions rarely obtain, of course, but much could often be done by ensuring adequate drainage and by denying the pigs access to muck-heaps. Since for the infective larvæ moisture is an absolute necessity, drainage is an important factor. Where sties are cleaned, the frequency of cleaning is also important. The egg passed in the urine becomes an infective larva in a week or rather less ; so that even where the ideal sty is thoroughly cleaned only once a week (or less frequently) the pigs may still continue to pick up infection. Various prophylactic measures are suggested in detail in le Roux's paper (1930B) which should be consulted. Therapeutic measures, for the present at least, are out of the question.

Economic Importance.

Apart from its pathological effects the parasite is economically important in that it renders the kidneys unfit for consumption. Writing of this parasite in the West Indies Cameron (1930, p.79) says that " It causes the

condemnation of a large proportion of kidneys." Moreover, where there is a high standard of meat inspection (as in England), carcasses with the kidneys removed may not be acceptable. According to Clunies Ross (1931) this has recently become an important factor in relation to Australian exports to Great Britain.

Within the Empire, Australia (except the more southerly regions) is worst affected. Kauzal (1930) has published some striking statistics relating to New South Wales. He shows that, of 58 pigs examined, 11 were infected in the liver and 5 in the lung. Furthermore, of 953 pigs examined only for perirenal infection, 230 (or 24·2 per cent.) were infected. However, from Kauzal's paper and from the publications of Clunies Ross, it is clear that Australia is fully alive to the problem and is taking active measures to deal with it. Some other tropical and subtropical parts of the Empire may not yet realize how serious this parasitic infection may be: hence these notes and the appended bibliography.

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